APPENDIX B

Minimum Standards for Surface Fault Rupture Hazard Studies

Sensitive Lands Evaluation & Development Standards (SLEDS)
Chapter 19.72, COTTONWOOD HEIGHTS CODE OF ORDINANCES

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1.0 INTRODUCTION

The Wasatch Fault Zone is a major tectonic feature of the intermountain region in the western United States. It extends from Fayette, Utah at the south to Malad, Idaho at the north, comprising about 230 miles. Surface faulting has occurred along the Wasatch Fault Zone in northern Utah throughout late Pleistocene and Holocene time. *"Surface faulting"* is a fault-related offset or displacement of the ground surface that may occur in an earthquake.

The Wasatch Fault Zone consists of a series of normal-slip fault segments where the earth experiences relative downward movement on the west side and upward movement on the east side. Ten major fault segments are recognized along the Wasatch Fault Zone, which are believed to be independent in regard to their potential for surface faulting. These segments have distinct geomorphic expression and are clearly visible on aerial photographs.

In the Salt Lake Valley, the Wasatch Fault Zone is represented by the Salt Lake City segment, which extends about 23 miles along the eastern edge of the valley. A portion of the Salt Lake City segment of the Wasatch Fault Zone is present in the foothills of Cottonwood Heights (the "*city*") on the eastern side of city. Documentation of repeated Holocene movements suggest that at least four major earthquake events have occurred in the last 6,000 years along Wasatch Boulevard near the mouth of Little Cottonwood Canyon.

In the event of an earthquake, a fault could break the ground surface below or near a structure and cause significant property damage, injuries and loss of life. In order to reduce risk from surface-fault-rupture hazards and to protect public health and safety, the city has defined a boundary for the sensitive lands that may have a heightened potential for surface fault ruptures and is requiring study for all new development or re-development within this area. Quaternary faults located within the Surface Fault Rupture Hazard Study Area should be considered active until proven otherwise.

The city requires a site specific geologic study for all properties that may be impacted by the Wasatch Fault Zone. The study must address the surface fault rupture potential and assess the suitability of the proposed development. In the event that a fault is discovered and deemed active (i.e., Holocene-age), appropriate building setbacks are required to minimize the potential damage during an earthquake.

The site-specific surface fault rupture hazard study requires a field investigation. This includes geologic documentation of an excavated trench or other pre-approved method of exploration and accompanying report that addresses the findings. The following information in this appendix describes the *minimum* standards required by the city for the surface fault rupture hazard study.

1.1 ***Purposes***.

(a) The purposes of establishing minimum standards for surface fault rupture hazard studies are to:

(i) Protect the health, safety, welfare, and property of the public by minimizing the potential adverse effects of surface fault ruptures and related hazards.

(ii) Provide guidance for property owners and land developers in performing reasonable and adequate studies of sensitive lands in the city.

(iii)Provide consulting engineering geologists with a common basis for preparing proposals, conducting investigations, and recommending setbacks.

(iv)Provide a consistent and objective framework for review of fault study reports.

(b) The procedures in this appendix are intended to provide the developer and consulting engineering geologist with an outline of appropriate exploration methods, standardized report information, and city expectations.

(c) These standards are the minimum level of effort required in conducting surface fault rupture hazard studies within the city. Considering the complexity of evaluating surface and near-surface faults, additional effort beyond the minimum standards may be required at some sites to adequately address the surface fault rupture hazard. The information presented in this appendix does not relieve the engineering geologist from his/her duty to perform additional geologic or engineering services he/she believes are necessary to assess the surface fault rupture potential at a site. In the interest of public safety, the city may, at any time, require additional information, studies, tests or other work that is not included in this appendix.

1.2 *Properties requiring a fault investigation*.

(a) Before approval of any land use, a fault study is required for properties within the surface fault rupture special study area that is located near the Wasatch Fault Zone, or any other property within the city that observes a fault trace during excavation. Appendix A of city code chapter 19.72 ("*chapter 19.72*") contains the Surface Fault Rupture Hazard Study Area Map (Map 1) that identifies areas with known active faults in the city. Properties within this area must perform site-specific geologic investigations. Development of any parcel within the Surface Fault Rupture Hazard Study Area requires submittal and review of a site-specific fault study prior to receiving a land use or building permit from the city. It is the responsibility of the applicant to retain a *qualified* (as provided in chapter 19.72) engineering geologist to perform the fault study.

(b) In addition, a fault study may be required if onsite or nearby fault-related features not shown on the Surface Fault Rupture Hazard Study Area Map are identified during the course of other geologic or geotechnical studies performed on or near the site or during construction.

1.3 *References and sources*.

(a) Guidelines for Evaluating Surface Fault Rupture Hazards in Utah (AEG, 1987).

(b) Guidelines to geologic and seismic reports, (CDMG, 1986a).

(c) Guidelines for preparing engineering geologic reports (CDMG, 1986b).

(d) Guidelines for Evaluating Potential Surface Fault Rupture/Land Subsidence Hazards in Nevada (Nevada Earthquake Safety Council, 1998)

(e) Fault Setback Requirements to Reduce Fault Rupture Hazards in Salt Lake County (Batatian and Nelson, 1999).

(f) Salt Lake County Geologic Hazards Ordinance (2002).

(g) Draper City Geologic Hazard Ordinance (2003).

(h) Guidelines for evaluating surface-fault-rupture hazards in Utah (Christenson and others, 2003).

2.0 MINIMUM STANDARDS FOR FAULT STUDIES

The following are the minimum standards for a comprehensive surface fault rupture study investigation.

2.1 ***Scoping meeting*.**

A scoping meeting with the DRC shall be scheduled by the consultant geologist. At this meeting, the developer, the city and the consultant will evaluate the fault investigation approach. The consultant should bring a site plan to the meeting that shows the following information:

(a) Proposed building locations (if known);
(b) Expected fault location(s) and orientation;
(c) Proposed trench locations, orientation, length, and depth (see Section 2.2, Fault Investigation Method);
(d) Extent of impact to vegetation and trees; and
(e) Method of controlling erosion and managing storm water.

The investigative approach should allow for flexibility due to unexpected site conditions. The field findings may require modifications to the work plan.

2.2 *Fault investigation method*. Inherent in fault study methods is the assumption that future faulting will recur along pre-existing faults and in a manner consistent with past displacement. The focus of fault studies is therefore to accurately locate existing faults. If faults are documented, the investigation shall also include (a) evaluation of the age of movement along the fault trace(s), and (b) estimation of amounts of past displacement, which is required in order to derive fault setbacks.

2.2.1 Previous studies and aerial photograph review. A fault study shall include review of available literature pertinent to the site and vicinity, including previous published and unpublished geologic/soils reports, and interpretation of available stereo-paired aerial photographs. The photographs reviewed should include more than one set and should include pre-urbanization aerial photographs, if available. Efforts must be made to accurately plot the locations of mapped or inferred fault traces on the property as shown by previous studies in the area.

2.2.2 Exploration methods. Subsurface trenching exploration is required. The engineering geologist shall clean and document ("*log*") trench exposures as described in Section 2.3.5. Existing faults may also be identified and mapped in the field by direct observation of young, fault-related geomorphic features, and by examination of aerial photographs. If trenching is not feasible due to the presence of shallow ground water or excessive fill, supplemental methods such as closely spaced Cone Penetration Test (CPT) soundings may be employed. Such supplemental methods must be discussed with the city prior to implementation and should be clearly described in the report.

(i) In lieu of conventional trenching or the CPT method, an alternative subsurface exploration program may be acceptable, depending upon site conditions. Such a program may consist of geophysical exploration techniques or a combination of other techniques.

(ii) When an alternative exploration program is proposed, a written description of the proposed exploration program along with an exploration plan should be submitted to the city for review and approval, prior to the exploration. The plan must include, at a minimum, a map of suitable scale showing the site limits, surface geologic conditions within several thousand feet of the site boundary, the location and type of the proposed alternative subsurface exploration, and the anticipated earth materials present at depth on the site.

(iii)The actual subsurface exploration program to be used on any specific parcel will be determined on an individual basis, considering the current state of technical knowledge about the fault zone and information gained from previous exploration on adjacent or nearby parcels. At all times, consideration must be given to safety, and trenching should comply with all applicable safety regulations.

2.2.3 Trench siting.

(i) Exploratory trenches must be oriented approximately perpendicular to the anticipated trend of known fault traces. The trenches shall provide the *minimum* footage of trenching necessary to explore the portion of the property situated in the surface fault rupture study area, such that the potential for surface fault rupture may be adequately assessed. When trenching to determine if faults might affect a proposed building site, the trench should extend beyond the building footprint at least the minimum setback distance for the building type (see Table A-1).

(ii) Test pits or potholes alone are neither adequate nor acceptable. In some instances more than one trench may be required to cover the entire building area, particularly if the proposed development involves more than one building. Where feasible, trenches shall be located outside the proposed building footprint, as the trench is generally backfilled without compaction, which could lead to differential settlement beneath the footings. Supplemental trenching may be required in order to:

A. Further refine fault locations (or the absence thereof);
B. Accurately define building restriction areas, and/or;
C. Provide additional exposures for evaluating the age of movement along fault traces.

2.2.4 Location determination. All trenches and fault locations must be surveyed by a registered professional land surveyor. Fault locations should be surveyed with an accuracy of 0.1 foot or better, so that structural setbacks can be developed. The fault locations (and all other features shown in the site plans) must be tied to a minimum of two Salt Lake County section corner monuments and the coordinate data shall be in US State Plane NAD83 (US Survey Feet). Other features in the site plan shall include property lines, building footprint, geologic features, utilities, existing structures, roadway, fences, etc. The location of all features, including the fault lines, shall be wet stamped and certified by the land surveyor.

2.2.5 Depth of excavation.

(i) The depth of the trenches will ultimately depend on the trench location, occurrence of ground water, stability of subsurface deposits, and the geologic age of the subsurface geologic units. As a minimum, however, trenches shall extend substantially below the A and B soil horizons and well into distinctly bedded Pleistocene-age materials, if possible. Where possible, the trenches should extend below Holocene deposits and should expose contacts between Holocene materials and the underlying older materials.

(ii) Appropriate safety measures pertaining to trench safety for ingress, egress, and working in or in the vicinity of the trench must be implemented and maintained. It is the responsibility of the person in the field directing trench excavation to ensure that fault trenches are excavated in compliance with current Occupational Safety and Health Administration excavation safety regulations.

(iii) Trench backfilling methods and procedures should be documented in order to establish whether additional corrective excavation, backfilling, and compaction should be performed at the time of site grading.

(iv) In cases where Holocene (i.e., active) faults may be present, but pre-Holocene deposits are below the practical limit of excavation, the trenches must extend at least through sediments that are clearly older than several fault recurrence intervals. The practical limitations of the trenching must be acknowledged in the report and recommendations must reflect resulting uncertainties.

2.2.6 Documenting trench exposures. Trench walls shall be cleaned of debris and backhoe smear prior to documentation. Trench logs shall be carefully drawn in the field at a minimum scale of 1-inch equals 5-feet (1:60) following standard and accepted fault trench investigation practices. Vertical and horizontal control must be used and shown on trench logs. Trench logs must document all significant geologic information from the trench and should graphically represent the geologic units observed; see Section 2.6.3(E). The strike, dip, and net vertical displacement (or minimum displacement) of faults must be noted.

2.2.7 Age dating.

(i) The engineering geologist shall interpret the ages of geologic units exposed in the trench. When necessary, radiocarbon or other age determinations methods shall be used. If evidence of faulting is documented, efforts shall be made to date the time of latest movement to determine whether recent (Holocene) displacement has occurred by using appropriate geologic and/or soil stratigraphic dating techniques. When necessary, obtain radiocarbon or other age determinations.

(ii) Many of the surficial deposits within Salt Lake Valley were deposited during the last pluvial lake cycle, referred to as the Bonneville lake cycle. Although late-stage Bonneville lake cycle sediments do not correspond to the Pleistocene-Holocene boundary (i.e., Bonneville lake cycle deposits are older than 10,000 years old), for purposes of evaluating fault activity, these deposits provide a useful regional datum, particularly when the entire Holocene sequence of sediments is not present.

(iii)For practical purposes, and due to documented Holocene displacement along the Salt Lake segment of the Wasatch fault, any fault which displaces late-stage Bonneville Lake Cycle deposits should be considered active unless the Bonneville deposits are overlain by clearly unfaulted *early* Holocene-age deposits. Conversely, the presence of demonstrably unbroken, undeformed, and stratigraphically continuous Bonneville sediments constitutes reasonable geologic evidence for the absence of active faulting.

2.3 ***Field review*.** A field review by the city's geologist is required during exploratory trenching. The applicant must provide a minimum of two business days notice to schedule the field review with the city. The trenches should be open, safe, cleaned, and a preliminary log completed at the time of the review. The field review allows the city to observe the subsurface data such as the age, type of sediments, and presence or absence of faulting with the consultant. Discussions about questionable features or an appropriate setback distance are encouraged, but the city will not help log the trench, explain the stratigraphy, or give verbal approval of the proposed development during the field review.

2.4 ***Recommendations for fault setbacks*.**

(a) To address wide discrepancies in fault setback recommendations, the city has adopted the fault setback calculation methodology for normal faults of Batatian and Nelson (1999) and Christenson and others (2003). The consultant should use this method to establish the recommended fault setback for critical facilities and structures designed for human occupancy. If another fault setback method is used, the consultant must provide justification in the report for the method used. Faults and fault setbacks must be clearly identified on site plans and maps.

(b) The minimum setbacks are based on the type and occupancy of the proposed structure as shown in Table A-1. The setbacks should be calculated using the following formulas presented below, and then compared to the minimum setback established in Table A-1. The greater of the two shall be used as the setback. Minimum setbacks apply to both the hanging wall and footwall blocks.

(c) Top of slope and/or toe of slope setbacks required by the local Building Code must also be considered; again, the greater setback must be used.

Downthrown Fault Block (Hanging Wall)

The fault setback for the downthrown block will be calculated using the following formula:
$S= U (2D + F/\tan\Theta)$ where:

$S =$ Setback within which structures for human occupancy are not permitted;
$U =$ Criticality Factor, based on the proposed occupancy of the structure (see Table A-1)
$D =$ Expected fault displacement per event (assumed to be equal to the net vertical displacement measured for each past event)
$F =$ Maximum depth of footing or subgrade portion of the building
$\Theta =$ Dip of the fault (degrees)

Upthrown Fault Block (Footwall)
The dip of the fault and depth of the subgrade portion of the structure are irrelevant in calculating the setback on the upthrown fault block. Therefore, the setback for the upthrown side of the fault will be calculated as:

S= U x 2D

The setback is measured from the portion of the building closest to the fault, whether subgrade or above grade. Minimum setbacks apply as discussed above.

2.5 *Small displacement faults*.

(a) Small-displacement faults are not categorically exempt from setback requirements. Some faults having less than 4 inches (100 mm) of displacement ("*small displacement faults*") may be exempt from setback requirements.

(b) Specific structural risk-reduction options such as foundation reinforcement may be acceptable for some small-displacement faults in lieu of setbacks. Structural options must minimize structural damage.

(c) Fault studies must still identify faults and fault displacements (both net vertical displacements and horizontal extension across the fault or fault zone), and consider the possibility that future displacement amounts may exceed past amounts. If structural risk-reduction measures are proposed for small displacement faults, the following criteria must be addressed:

(i) Reasonable geologic data indicating that future surface displacement along the particular fault will not exceed 4 inches.

(ii) Specific structural mitigation to minimize structural damage.

(iii)A structural engineer must provide appropriate designs and the city shall review the designs.

2.6 *Required outline for surface fault rupture hazard studies*.

(a) The information described herein may be presented as a separate surface fault rupture hazard report or it may be incorporated within other geology or engineering reports that may be required for the property.

(b) The report shall contain a conclusion regarding the potential risk of surface fault rupture on the subject property and a statement addressing the suitability of the proposed development from a surface fault rupture hazard perspective. If exploration determines that there is a potential for surface rupture due to faulting, or if gradational contacts or other uncertainties associated with the exploration methods preclude the determination of absence of small fault offsets, the report should provide estimates of the amplitude of fault offsets that might affect habitable structures.

(c) Surface fault rupture hazard reports submitted to the city are expected to follow the outline and address the subjects presented below. However, variations in site conditions may require that additional items be addressed, or permit some of the subjects to be omitted (except as noted).

2.6.1 Report.

(i) *Statement of the purpose and scope of work*. The report shall contain a clear and concise statement of the purpose of the study and the scope of work performed for the study.

(ii) *Site description and conditions*. The report shall include information on geologic units, graded and filled areas, vegetation, geomorphic features, existing structures, and other factors that may affect site development, choice of investigative methods, and the interpretation of data.

(iii) *Geologic and tectonic setting*. The report shall contain a clear and concise statement of the general geologic and tectonic setting of the site and surrounding vicinity. This section should include a discussion of active faults in the area, paleoseismicity of the relevant fault system(s), and should reference relevant published and unpublished geologic literature.

(iv) *Methods of investigation*.

A. Review of published and unpublished maps, literature and records concerning geologic units, faults, surface and ground water, and other factors.

B. Stereoscopic interpretation of aerial photographs to detect fault-related topography, vegetation or soil contrasts, and other lineaments of possible fault origin. Reference the photograph source, date, flightline numbers, and scale. Salt Lake County has an excellent collection of stereoscopic aerial photographs dating back to 1937 (including 1937, 1940, 1958, 1964, and 1985).

C. Observations of surface features, both on-site and offsite, including mapping of geologic and soil units; geomorphic features such as scarps, springs, and seeps (aligned or not); faceted spurs, offset ridges or drainages; and geologic structures. Locations and relative ages of other possible earthquake-induced features such as sand blows, lateral spreads, liquefaction, and ground settlement should be mapped and described. Slope failures, although they may not be conclusively tied to earthquake causes, should also be noted.

D. The report shall include a description of the program of subsurface exploration, including trench logs, purpose of trench locations, and a summary of trenching or other detailed, direct observation of continuously exposed geologic units, soils, and geologic structures. All trench logs shall be at a scale of at least 1-inch is equal to five-feet.

E. The report must describe the criteria used to evaluate the ages of the deposits encountered in the trench, and clearly evaluate the presence or absence of active (Holocene) faulting.

(v) *Conclusions*.

A. Conclusions must be supported by adequate data and shall contain, at a minimum a summary of data upon which conclusions are based.

B. Location of active faults, including orientation and geometry of faults, amount of net slip along faults, anticipated future offset, and delineation of setback areas.

C. Degree of confidence in and limitations of data and conclusions.

(vi) *Recommendations*. Recommendations must be supported by adequate geologic data and appropriate reasoning behind each statement. Minimum recommendations shall include:

A. Recommended setback distances per Section 2.4. Supporting calculations must be included. Faults and setbacks must be shown on site maps and final recorded plat maps.

B. Other recommended building restrictions or use limitations (i.e., placement of detached garages, swimming pools, or other non-habitable structures).

C. Need for additional or future studies to confirm buildings are not sited across active faults, such as inspection of building footing or foundation excavations by the consultant.

2.6.2 Report references. Reports must include citations of literature and records used in the study, referenced aerial photographs or images interpreted (air-photo source, date and flight number, scale), and any other sources of data and information, including well logs, personal communications, etc.

2.6.3 Support information. At a *minimum*, each geologic report must include the following support information:

(i) *Location map*. A site location map depicting topographic and geographic features and other pertinent data. Generally a 1:24,000-scale USGS topographic base map will suffice.

(ii) *Geologic map*. A regional-scale map (1:24,000 to 1:50,000 scale) is generally adequate. Depending on site complexity, a site-scale geologic map (minimum 1 inch= 200 ft or more detailed) may also be necessary. The map should show Quaternary and bedrock geologic units, faults, seeps or springs, soil or bedrock slumps, and other geologic and soil features existing on and adjacent to the project site. Geologic cross-sections may be included as needed to illustrate 3-dimensional relationships.

(iii)*Site plan and fault map*. A detailed survey-grade site plan is required. The site plan shall be prepared and certified by a licensed surveyor. The site plan should be at a minimum scale of at least 1 inch = 200 feet and should clearly show site boundaries, proposed building footprints, existing structures, streets, slopes, drainages, exploratory trenches, boreholes, test pits, geophysical traverses, utilities, property lines, fences, slopes, trees, retaining walls, adjacent structures and any other appurtenant features. The site plan shall include the locations of subsurface investigations and site-specific geologic mapping performed as part of the geologic investigation, including boundaries and features related to any geologic hazards, topography, and drainage. The site map must also show the surface fault rupture hazard study area within the subject site the locations of all faults identified during the investigation conducted for the subject site including inferred location of the faults between trenches and must show all recommended setbacks from identified faults and from the ends of trenches located within the surface fault rupture hazard study area. The site map must show the location of all proposed flexible expansion joints for utilities. Both buildable and non-buildable areas shall be clearly identified. All features on the map shall be tied to a minimum of two public survey monuments tied with bearings and distances. The datum shall be submitted in US State Plane NAD83 (US Survey Feet) and wet-stamped by a licensed surveyor. The site map should include a legend describing pertinent items shown on the map.

(iv) *Exploratory trench logs*. Trench logs are required for each trench excavated as part of the study, whether faults are encountered or not. Trench logs shall accurately depict all observed geologic features and conditions. Trench logs are hand- or computer-generated maps of excavation walls that show details of geologic units and structures. Logs must be submitted with a scale and not be generalized or diagrammatic. The minimum scale is 1 inch = 5 feet (1:60) with no vertical exaggeration. Trench logs must accurately reflect the features observed in the trench (see Section 2.3.6). Photographs shall not be used as a substitute for trench logs. However, it is recommended that a photographic log of the trench also be created.

(v) *Contents of trench logs*. Trench logs shall include orientation and indication of which trench wall was logged; trench top and bottom; stratigraphic contacts; stratigraphic unit descriptions including lithology, USCS soil classification, genesis (geologic origin), age, and contact descriptions; soil (pedogenic) horizons; marker beds; and deformation or offset of sediments, faults, and fissures. Other features of tectonic significance such as buried scarp free-faces, colluvial wedges, in-filled soil cracks, drag folds, rotated clasts, lineations, and liquefaction features including dikes, sand blows, etc. should also be shown. Interpretations of the age and origin of the deposits and any faulting or deformation must be included, based on depositional sequence. Fault orientation and geometry (strike and dip), and amount of net displacement must be measured and noted. Provide evidence for the age determination of geologic units. For suspected Holocene faults where unfaulted Holocene deposits are deeper than practical excavation depths, clearly state the study limitations

(vi) *Exploratory boreholes and CPT soundings*. If boreholes or CPT soundings are utilized as part of the investigation, reports shall include the logs of the borings/soundings. Borehole logs must include lithology descriptions, interpretations of geologic origin, USCS soil classification or other standardized engineering soil classification (include an explanation of the classification scheme), sample intervals, penetrative resistance values , static ground-water depths and dates measured, total depth of borehole, and identity of the person logging the borehole. Electronic copies of CPT data files should be provided to the city's reviewer, upon request. Since boreholes are typically multipurpose, borehole logs should contain standard geotechnical and geologic data such as lithology descriptions, soil class, sampled intervals, sample recovery, blow-count results, static ground-water depths with dates measured, total depth of boreholes, drilling and sampling methods, and identity of the person logging the borehole. In addition, borehole, geoprobe hole, and cone-penetrometer logs for fault studies should include the geologic interpretation of deposit genesis for all layers. Also include boring logs or logs from other exploration techniques, when applicable, prepared with standard geologic nomenclature.

(vii) *Geophysical data*. All geophysical data, showing stratigraphic interpretations and fault locations, must be included in the report, along with correlations to trench or borehole logs to confirm interpretations.

(viii) *Photographs*. Photographs of scarps, trench walls, or other features that enhance understanding of site conditions and fault-related conditions are not required but should be included when deemed appropriate. Composite, rectified digital photographs of trench walls may be used as background for trench logs, but features as outlined in section F **(?????)** above must still be delineated.

(ix) *Type and number of buildings*. A description of the location and size of site and proposed type and number of buildings (if known) planned for the site.

(x) *Specific recommendations*. Specific recommendations consistent with the purposes set forth in chapter 19.72, including a discussion of the evidence establishing the presence or absence of faulting including ages and geologic origin of faulted and unfaulted stratigraphic units and surfaces. The discussion shall include the location of faults, including orientation and geometry of faults, maximum amounts of vertical displacement on faults, anticipated future offsets, calculation of setbacks, and delineation of setback (non-buildable) areas if applicable. Recommendations must be supported with geologic evidence and appropriate reasoning that is supported by industry standards. Other recommended building restrictions, use limitations, or risk-reduction measures such as placement of detached garages, swimming pools, or other non-habitable structures in fault zones, or use of reinforced foundations for small-displacement faults.

(xi)*Support data*. All data upon which recommendations and conclusions are based shall be clearly stated in the report. This includes a complete citations of literature and records used in the study including personal communications, published and unpublished geologic literature with emphasis on current sources that discuss Quaternary faults in the area, historical seismicity (particularly earthquakes attributed to area faults), and geodetic measurements where pertinent. A listing of aerial photographs used and other supporting information, as applicable.

(xii) *Suitability of the development*. A statement shall be provided regarding the suitability of the proposed development from a geologic hazard perspective.

(xiv) *Flexible expansion joints*. All sewer and water lines that cross any fault on the subject site shall be equipped with flexible expansion joints to prevent rupture and consequential damage in the event of an earthquake.

(xv) *Foundation excavation inspection*. Recommended inspection of building foundation excavations during construction to confirm surface and subsurface investigations.

(xvi) *Current signature and seal*. A current signature and seal of the investigating, Utah-licensed professional geologist(s). Qualifications giving education and experience in engineering geology and fault studies can be presented through a CV or resume format in the appendix of the report.

(xvii) *Conclusions*. Conclusions that are clearly supported by adequate data included in the report, that summarize the characteristics of observed surface fault rupture hazards, and that address the potential effects of all identified faults on the proposed development, particularly in terms of risk and potential damage. All other geologic hazards identified during the investigation should be discussed. A discussion regarding the degree of confidence and/or limitations of the data should also be included. Supporting data relevant to the investigation not given in the text such as cross-sections, conceptual models, fence diagrams, survey data, water-well data, and qualifications statements. Specific recommendations for additional or more detailed studies, as may be required to understand or quantify all geologic hazards identified at the subject site.

Table A-1. Setback recommendations and criticality factors (U) for IBC occupancy classes (International Code Council, 2003).

Class (IBC)	**Occupancy group**	**Criticality**	**U**	**Minimum setback**
A	Assembly	2	2.0	25 feet
B	Business	2	2.0	20 feet
E	Educational	1	3.0	50 feet
F	Factory/Industrial	2	2.0	20 feet
H	High hazard	1	3.0	50 feet
I	Institutional	1	3.0	50 feet
M	Mercantile	2	2.0	20 feet
R	Residential (R-1, R-2, R-4)	2	2.0	20 feet
R-3	Residential (R-3, includes Single Family Homes)	3	1.5	15 feet
S	Storage	-	1	0
U	Utility and misc.	-	1	0
	Table A- 2	1	3.0	50 feet

Table A-2

Additional Structures Requiring Geologic Investigation

A. Buildings and other structures that represent a substantial hazard to human life in the event of failure, but not limited to:

1. Buildings and other structures where more than 300 people congregate in one area.
2. Buildings and other structures with elementary school, secondary school or day care facilities with occupancy greater than 250.
3. Buildings and other structures with occupancy greater than 500 for colleges or adult education facilities.
4. Health care facilities with occupancy greater than 50 or more resident patients but not having surgery or emergency treatment facilities.
5. Jails and detention facilities.
6. Any other occupancy with occupancy greater than 1000.
7. Power generating stations, water treatment or storage for potable water, waste water treatment facilities and other public utility facilities.
8. Buildings and other structures containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released.

B. Buildings and other structures designed as essential facilities including, but not limited to:

1. Hospitals and other care facilities having surgery or emergency treatment facilities.
2. Fire, rescue and police stations and emergency vehicle garages and fueling facilities.
3. Designated emergency shelters.
4. Designated emergency preparedness, communications, and operation centers and other facilities required for emergency response.
5. Power-generating stations and other public utility facilities required as emergency backup facilities for facilities and structures included in this table.
6. Structures containing highly toxic materials as defined by the most recently adopted version of the IBC where the quantity of the material exceeds the maximum allowable quantities defined by the most recently adopted version of the IBC.
7. Aviation control towers, air traffic centers and emergency aircraft hangars.
8. Buildings and other structures having critical national defense functions.

8\. Water treatment and storage facilities required to maintain water pressure for fire suppression.